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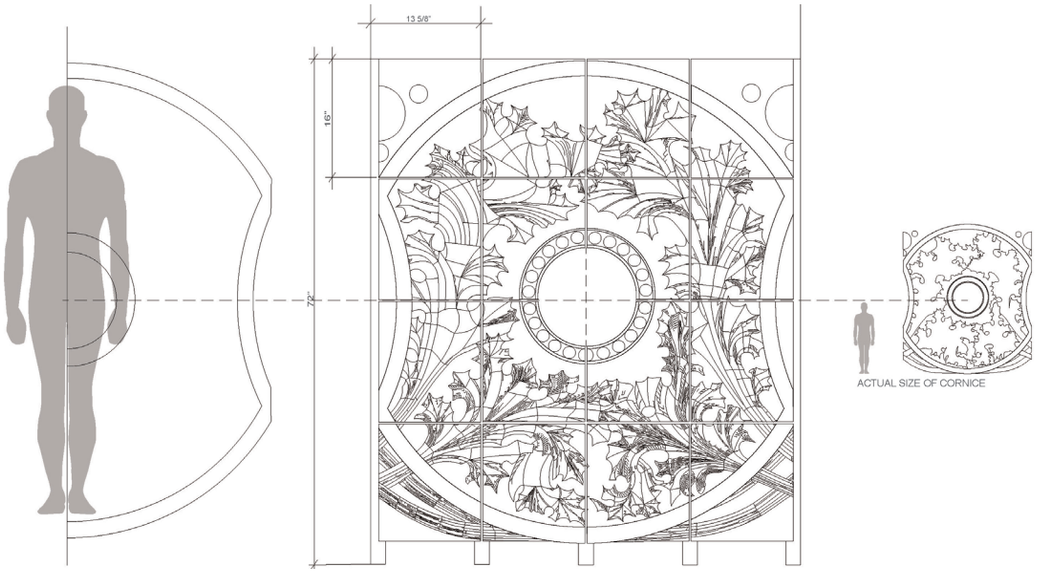
Craft in the Digital Era

Louis Sullivan, Digital Technology, and Designbuild Education

Keith Van de Riet

"...in the Machine lies the only future of art and craft—as I believe, a glorious future..."

Frank Lloyd Wright
The Art and Craft of the Machine,
1901



Perhaps digital craft in architecture can be effectively calibrated through emulation of the masters. This is not to suggest we retrogress to periods of architectural style, but rather leverage relevant benchmarks within pedagogical models to establish standards of craft in digital design and fabrication. By adopting this preservation-oriented and Beaux-Arts style of learning, computational technologies can be vetted through the modeling and construction of architecture embedded with some of the most recognized achievements of human hand and mind. Craft in architecture now mostly means relying on highly skilled technicians in the development of machine-based architectural components, yet the highly ornate details of Louis Sullivan's terra cotta work relied on qualified human experience, hand-drafted details and close collaboration between designer, sculptor and producer. Through a proper union of machine and human craft, architectural expression might ultimately reflect Wright's prophetic epigraph, but this requires an understanding of respective roles and opportunities, such that a co-production of craft among machine, hand and mind can emerge.

Sullivan and the Re-Emergence of Ornamentation

Sullivan's work was deeply rooted in the social, cultural and technological context of the mid to late nineteenth century. Dankmar Adler and Louis Sullivan were at the forefront of verticality in design and engineering—their buildings epitomized the cutting edge of technology with steel skeleton frames and exhibited craft with stylized organic motifs in terra cotta cladding. Nearly synonymous with craft, the architectural ornament—its purpose and method of production—was then at the core of debate between human and machine technology. Sullivan attempted to reconcile ornament and the tall office building by integrating human-made details with program, structure, massing, and materiality, such that the firm's buildings were highly expressive of these layers in the new typology. His belief was that each building should have intrinsic expressions reflected by the façade in materiality, form, and content.[1] Thus, he arrived at "form follows function."

In practice, his was a synthesis of styles and individualism, and he bridged the gap between purists of the Arts and Craft Movement and the emerging industrial-scale architecture of the commercial office building.[2] Sullivan's botanical motifs departed from the accepted styles of the majority of his peers and combined inspiration from Gothic Revival, Arts and Crafts, and his personal experience in nature, among others. Likely influential during his time, prevalent evolutionary theories that describe morphogenesis of organisms may have played a role to inspire Sullivan; his work captured the growth logics of natural systems rather than a tendency toward static symbolism. Nature was inseparable from culture; celery leaves, used in ancient Greece, Rome, and Egypt as victory wreaths during Olympics, adorn the Wainwright Building frieze and symbolized for Sullivan the opportunities and values of American democracy in the form of the tall office building. Sullivan's *A System of Architectural Ornament* would later formalize his iterative development of organic architecture details with a theoretical framework that foreshadowed the parametric and algorithmic geometry of contemporary architecture—a link that further justifies his selection for study with digital craft.[3]

Perhaps best demonstrated with the recent surge in parametrically-generated and performance-based surfaces in buildings, architectural styles have pivoted back towards expression of technology, culture, and diversity.[4,5] The architectural ornament has re-emerged within a digitally-driven design process, the effect of which may lend itself to translate the invisible forces of contemporary culture into architectural dialect. Digital craft and the designer's ability to cross-link social, historical and technological contexts may be critical in a globalized world where the struggle to retain a sense of individual culture and place has become paramount in the search for meaning and identity in architecture. This opportunity for digital technology to bridge between culture, environment, and craft requires that designers actively engage in the management of digital tools and their effects during the design and fabrication process.

Evolving Craft with Digital Tools

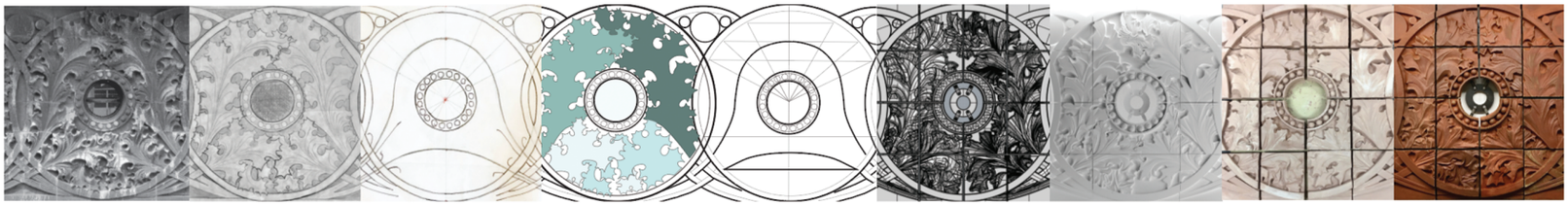
Richard Sennet presents a convincing case that at the foundation of an individual's established craft is forming intimate connection between head and hand, and repetitive learning of this nature forms a sustainable pattern of habits in problem solving and what he describes as problem finding.[6] In this definition, craft evolves with the working hand and engaged mind, and experience transforms into tacit knowledge at the hand of the craftsman. It's also the case that digital design and fabrication require many of the same habits as traditional tools in order to cultivate craft. For example, deliberate practice over time to become an expert and establishing precision standards as routine habit are both necessary for high standards of craft to emerge in digital and non-digital realms. In addition to these shared standards and so we are not neutral towards technology and its essence,[7] other important habits specific to digital craft are required. These include, but are not limited to, anticipating machine and material behaviors, translating tool parameters into design decisions, and developing original geometry. How best to evolve these digital habits?

One method to ensure well-developed and precise digital work is with accountability in the form of a deliverable project. In this way, young designers are immersed in the process of bringing a project from concept to completion and inevitably encounter the hurdles of transitioning a digital model to the real world. This serves to provide accountability for craft in the digital environment, as well as testing the capacity of digital fabrication tools to replicate and advance the tacit knowledge historically transferred to material by qualified hands. On the fabricating end, this exposes the computer model to dimensional and directional constraints of the machine, as well as practical considerations in the final assembly. Material tolerance, shrinkage and expansion, color variation, thermal properties and gravitational and other forces, tend to be absent in the digital

environment. Designbuild[8] studios reestablish these factors. Different from "design-build" or "design/build" as a professional project delivery method, "designbuild" is described as the synthesis of the action design and the action build.

In the case of the Sullivan details produced in the designbuild studio, these natural forces came to foreground as the 3-D models transitioned from digital environment to burnt clay. The consistency and stability of cast stone and plaster as alternative final media became obvious as groups diverged—two in clay, one in concrete, one in plaster. The groups working with terra cotta lost approximately 12% of clay volume during firing, and although predicted by kiln-fired shrinkage bars, this factor made the final assembly a tolerance-heavy dimension that was required to accommodate material behavior without compromising tile alignment. In our case, the joints between tiles remained void, which removes the ability to hide inconsistencies with mortar as was done historically on the building. These factors, in addition to the challenges of modeling floral patterns in the first place, all reinforced the critical need for iterative development, precision and anticipation—together emerging as hybrid process to establish craft.

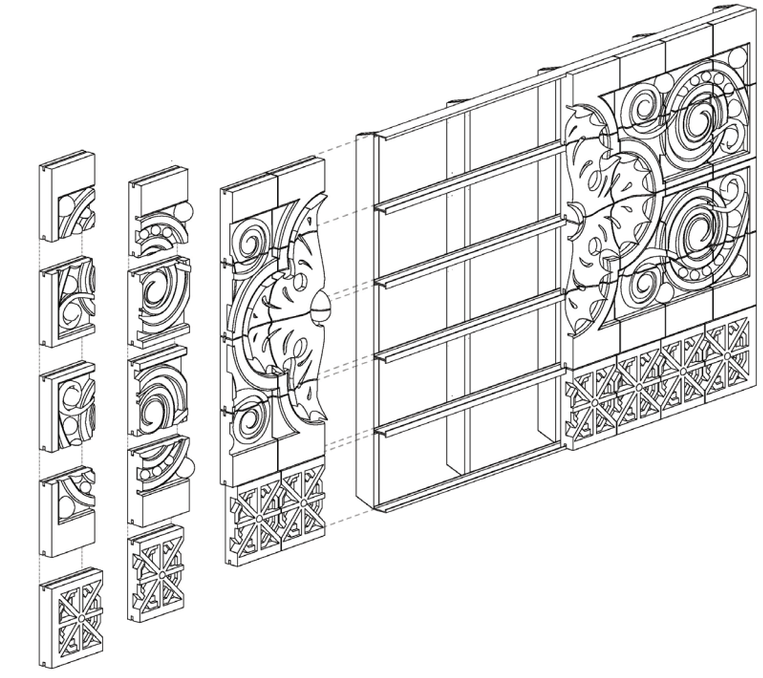
Digitally-developed work can be further enhanced by translating tool parameters into design decisions. Although not a new habit— the craftsman has always sought to embellish or disguise tool markings—the ma-



chine recreates this material effect with explicit coded instruction that may be more difficult to grasp as a design decision due to the disconnect between mind, hand, and machine. These patterned signatures are linked to a variety of parameters that can be manipulated with tool orientation, resolution, and shape. They might reveal subtle material features, enhance a design with correlated textures, or in some cases be suppressed to disguise the process. Techniques can be additive or subtractive, both of which rely on resolution of printing/tooling as a major determinant in the final surface characteristics and fabrication time. These markings can and should include orientation and scaling of pattern as it relates to structure, aesthetic or environmental performance.

Further critical to digital craft is the experience gained through development of original geometry. The availability of off-the-shelf components has substantially undermined our ability to reflect on design decisions in a project. With the Sullivan precedent (and many historical details) no drawings or surveys exist, so students began with photographs of the Wainwright Building. Digital models were built directly on photographs taken from elevation view of the building details. Sketching proved once again the vital instrument it is to architecture, regardless of the technologies that follow it, to analyze, uncover, and comprehend the organization of the complex patterns. Essentially, it was a delaminating of Sullivan's iterative process of developing organic geometry to uncover the scaffold on which divergent floral attributes were constructed. This ultimately determined the hierarchy of lines within the detail to extract and utilize in the production of 3-D surfaces, and this hierarchy provided the origins to a cascade of surfaces to follow, much in the way Sullivan conceived of the details.

Beyond these more practical considerations, accountability in the form of a designbuild project places the designer within the realm of traditional craftsmen and building trades. As a result of this overlap of abstract and field-based knowledge, a common space emerges that fosters collaboration and feedback throughout the design process. This reconnects those responsible for the tacit knowledge dimensions of a project with the architect that in many cases has become far removed from these productive knowledge spaces. In the Sullivan project, students sought expertise in ceramics, concrete, and plaster. The terra cotta work proved most difficult even with collaborative expertise, due to the plaster molds, hand-pressed tiles, and kiln firing that followed the digital machining of foam molds. In this way, the emphasis on digital craft in the studio was balanced with traditional methods, and a single project traversed centuries of technology from ancient ceramic techniques to today's digital workflow.



Conclusion

Society is primed to embrace diverse expressions of culture and environmental performance within

buildings. At the same time, architects are more digitally-equipped yet further removed from physical craft, a disparity emblematic of the modern over-emphasis on the role of theory at the expense of practice.[9] Technology has migrated upstream in the designer's workflow and accelerated the erosion of practical knowledge from the architect. Great thinkers, artists, and humanists have fought the machine's advance into craft for centuries, all the while losing ground to the ever broadening reach of technology. Characterized as a "border war," Donna Harraway contends the exchange between humans and technology has as its stakes, "the territories of production, reproduction and imagination."[10] In architectural practice, imagination might be the most recent human domain to be slowly handed over to the machine. Not without hope though, as Harraway describes a pleasure in the confusion of boundaries between human and machine and the responsibility in negotiating this relationship—a tension that without proper training in technology and craft might be difficult to sustain.

Notes

1. Sullivan, Louis H. "The Tall Office Building Artistically Considered," in *Kindergarten Chats and Other Writings.* George Wittenborn & Co., 1947.

2. Gelernter, Mark. *A History of American Architecture: Buildings in their cultural and technological context.* University Press of New England, 1999.

3. Sullivan, Louis. *A System of Architectural Ornament according with a philosophy of man's powers.* New York: Press of the American Institute of Architects, inc. 1924.

4. See Kolarevic, Branko and Kevin Klinger. "Manufacturing / Material / Effects" in *Manufacturing Material Effects: Rethinking Design and Making in Architecture.* Routledge, 2008.

5. See Moussavi, Farshid and Michael Kubo (eds). *The Function of Ornament.* Actar, 2015.

6. Sennet, Richard. *The Craftsman.* Yale University Press, 2008.

7. See Heidegger, Martin. *The Question Concerning Technology and Other Essays*. Harper Torchbooks, 1977. Heidegger describes the essence of technology as a "bringing forth or revealing of truth" and the perils of imparting neutrality to it as "…we are delivered over to it in the worst possible way when we regard it as something neutral; for this conception of it…makes us utterly blind to the essence of technology."

8. See Kraus, Chad (ed). *Designbuild Education.* Routledge, 2017. Different from "design-build" or "design/build" as a professional project delivery method, "designbuild" is described as the synthesis of the action *design* and the action *build*.

9. See Turnbull, David. *Masons, Tricksters and Cartographers*. Routledge, 2000.

10. Harraway, Donna. "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," in *Simians , Cyborgs and Women: The reinvention of Nature*. Routledge, 1991.

Students in the Fall 2016 ARCH 509 Studio

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